Purdue Computational Homeland Security Framework

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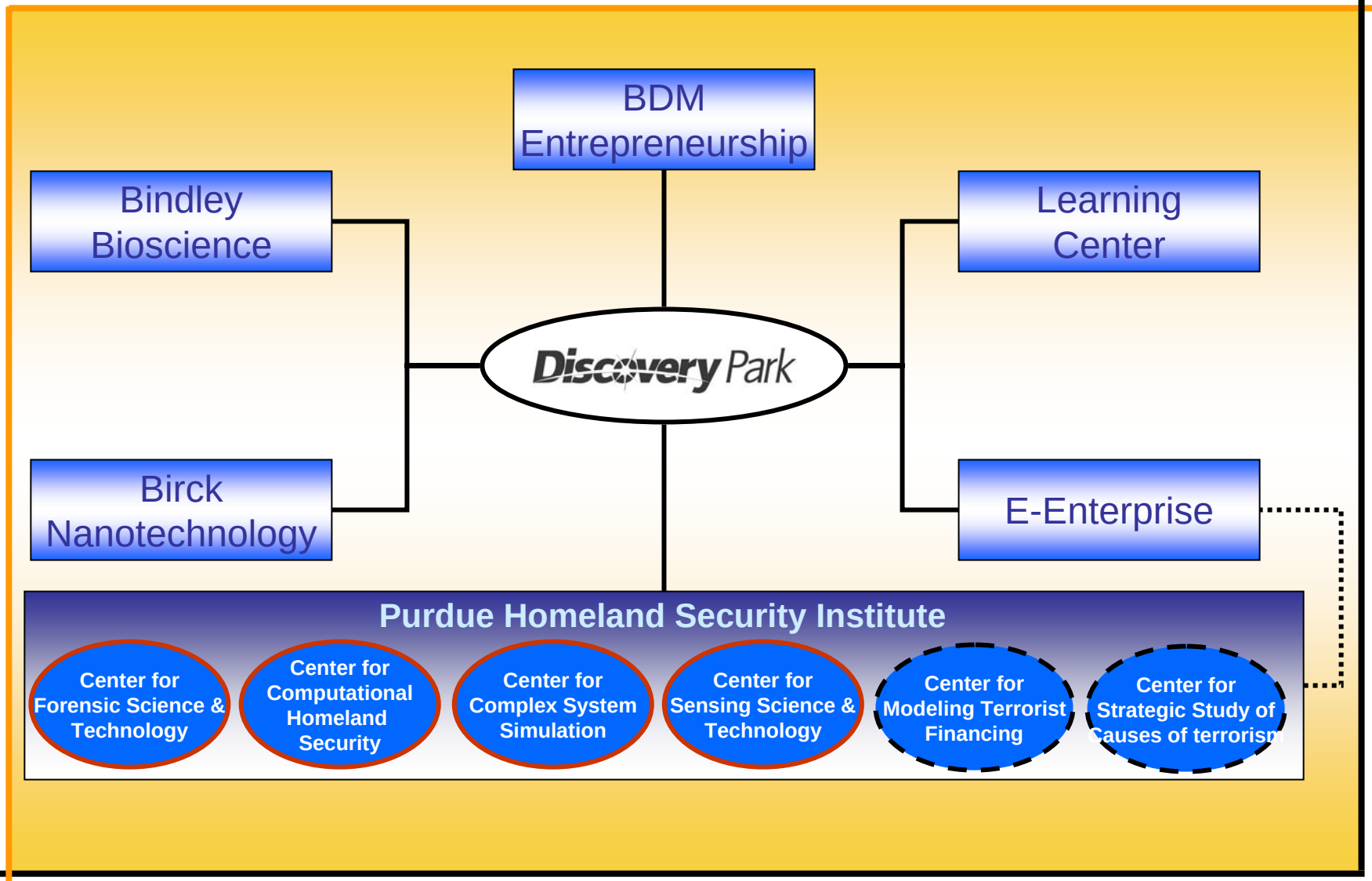
PHSI's Evolving Structure



PHSI Initiatives

- **Public Health**
  - **Military Family Research Institute, ..**
- **Animal, Plant, and Food**
  - **Part of Kansas State led consortium (Plant track)**
  - **Part of Michigan State led consortium (Animal track)**
- **Critical Infrastructure**
  - **Power Grid**
    - **Center for Complex Systems**
  - **Computer and Telecommunications Network**
    - CERIAS, IT@P, CWSA, CRI, ..
  - **Manufacturing System**
    - **Advanced Manufacturing Institute, Product Lifecycle Management**
  - **Air/Land/Maritime Transportation and Infrastructure**
    - **Transportation, Distribution, and Logistics (TDL)**
  - **Financial Network**
  - **Water and Sewage System**

Threat Modeling and Research

- **Chemical and Biological Terrorism**
  - **Part of NIH RCE**
- **Terrorism with WMD**
- **Cyber Terrorism**
  - **CERIAS**
- **High explosives and fire**
- **Terrorist Financing and money laundering**

HS Strategies Research

- **Response and Recovery**
  - **Economic, Social, and Psychological Impact Analysis**
- **Countermeasures**
  - **People, Process, and Technology**
- **Early Warning and Prevention**
  - **Sensors, Detectors, and Instruments Integration**
- **Design for Robustness**
  - **Analytical, Empirical, and Computational methods**

Measured Response Objectives

- A vehicle to promote understanding and dialogue on actions and issues related to the development of an effective homeland Security program
- A forum and base for mutual understanding between agencies and players involved in homeland security
- A tool for decision makers to test potential resources allocation and planning options in a virtual environment

9 human teams + > 470K agents + emotional model + epidemiological model + mobility model

Citizens' value:

- Basic Needs
- Security
- Civil liberties
- Financial Security
- Health
- Mobility
- Information

Politicians manage:

- Public Mood
- Economy

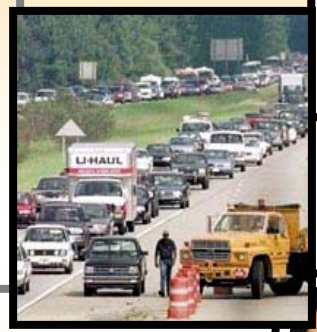
Responders manage:

- Prevention
- Mitigation
- Public Health
- Orderly movement of traffic and people

Dialogue, Experiential Engagement, Informed Consensus

The Scenario

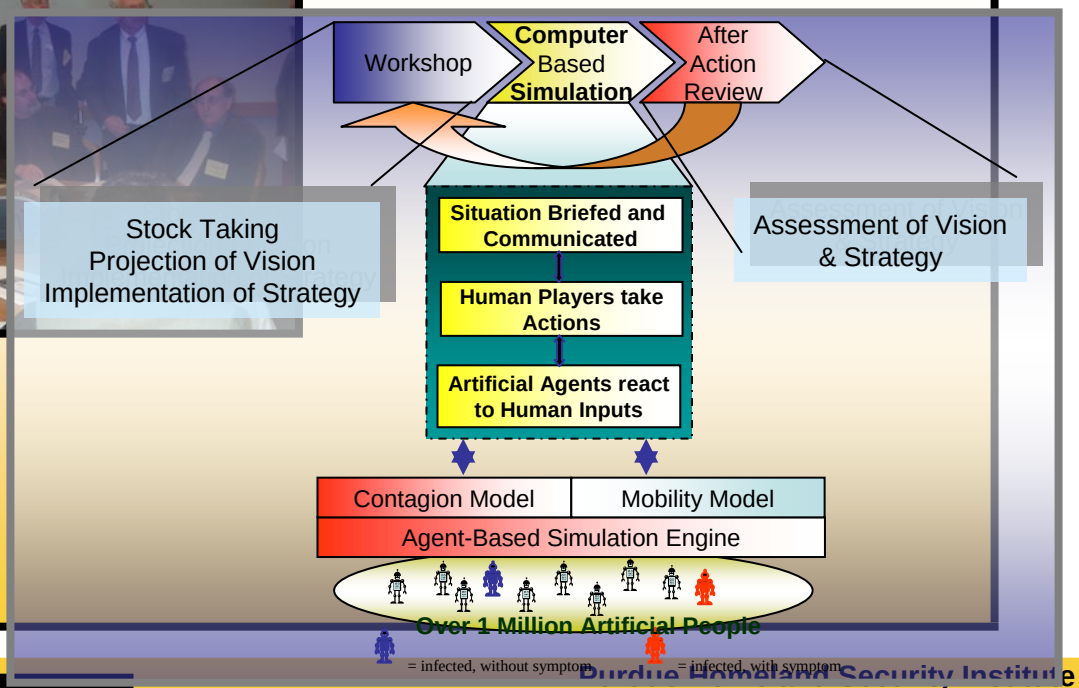
International Festival of Music: An event billed as the “greatest and largest” music festival in the world. Six concerts and twelve smaller events to be held at various locales on Saturday July 27 attracted 75,000 people. Sunday July, 28-the largest gala, to be held at the State fairgrounds; ten top groups from the U.S., Europe, and Africa will be performing in three megastar sessions. Attendance is expected to top 300,000. As of 0800 on Sunday, 100,000 were camped on the grounds to get a good view. An estimated 200,000 were en route at this time.



- **Federal**
  - Homeland Security
  - Human & Health Services
  - Department of Transportation
- **State**
  - Homeland Security
  - Human & Health Services
  - Department of Transportation
- **Local**
  - Homeland Security
  - Human & Health Services
  - Department of Transportation

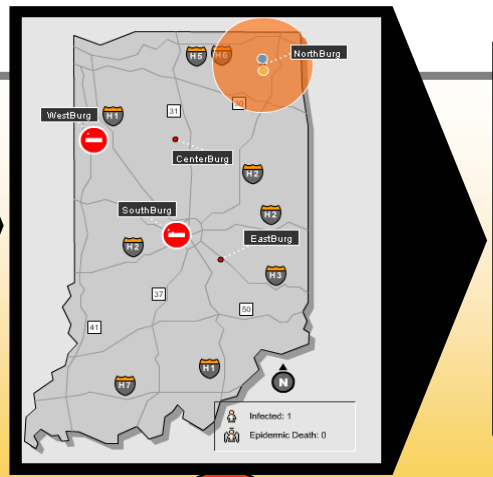
Continuous Experimentation Process

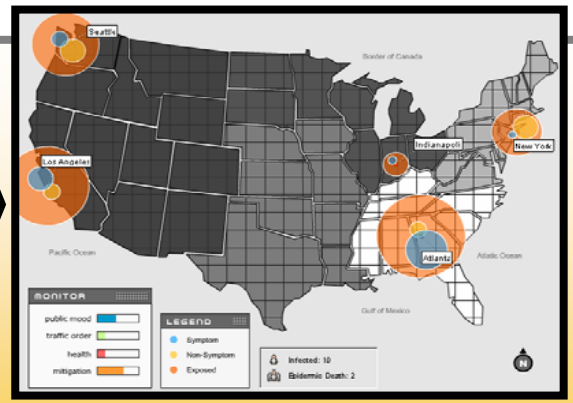
- Information – What do we know? What more do we need to know? Where can we acquire it?
- Analysis – How reliable is our information? What does it mean
- Judgment – Import? What should we do about the situation? What can we do about it? Resource availability.
- Communication – Whom should we inform? How? How much within CM system? Within government? Outside government?
- Decisions? Who makes them? What range of options are available? What resources are available?
- Decision implementation – Resource utilization, timing, communication



Lessons Learned

- Risk Analysis
  - Immediate versus delayed disclosure to the public
  - Level and extent of disclosure
  - Intensity of intervention
  - Short term versus long term political and economic impact
- Decisiveness and Timeliness of Actions
  - Clarity in selection and acceptance of decision maker
  - Decision makers need to be trained to be decisive and take timely actions
- Organization
  - Current organizational structures are not designed for optimal performance in homeland security
- Coordination
  - Mutual aid agreements across state lines are needed
  - Mismatch exists between elected officials and responders
- Value Judgment
  - Vaccination, isolation, quarantine





Endemic **Epidemic** **Pandemic**

The Breaking Point Game Board

State Military UN +

State Military UN +

(US – ASEAN interest)

Int. Aff Trnspt Hlth

(Indonesia Government)

Int. Aff Trnspt Hlth

(Jakarta Government)

Leader

Organized Force

Uncommitted

Red Sympathizer

Blue Sympathizer

IJ

Terrorist

PMESII

Pro Red

Pro Blue

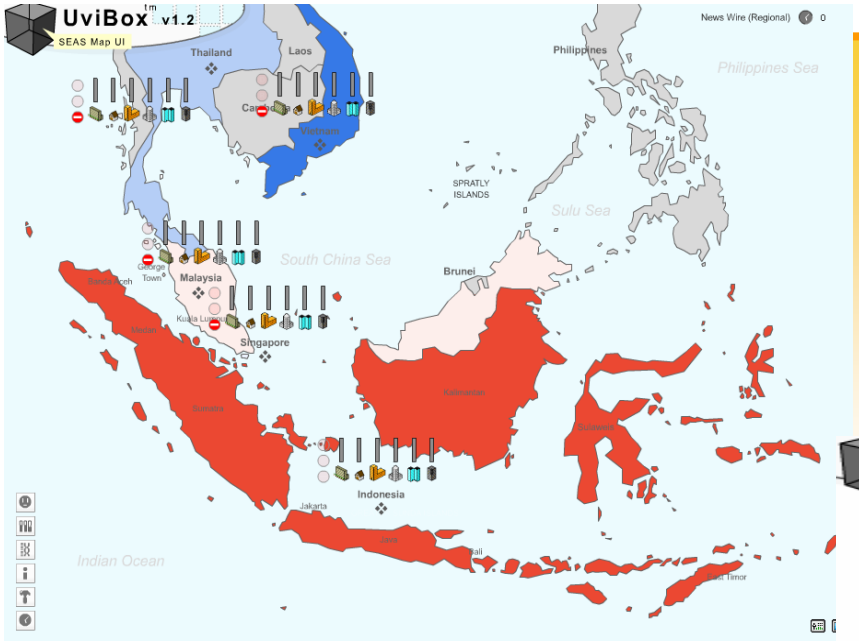
Human Players

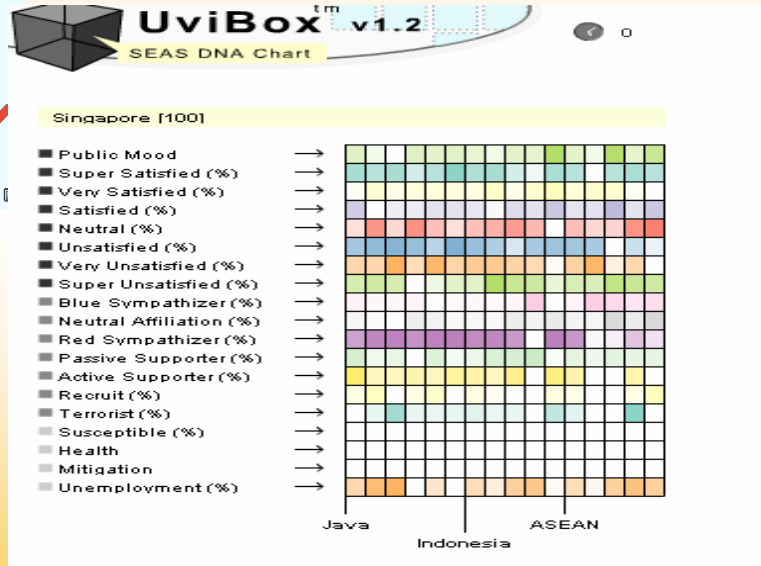
Group/Community

Artificial Agent (Leader)

Artificial Agent

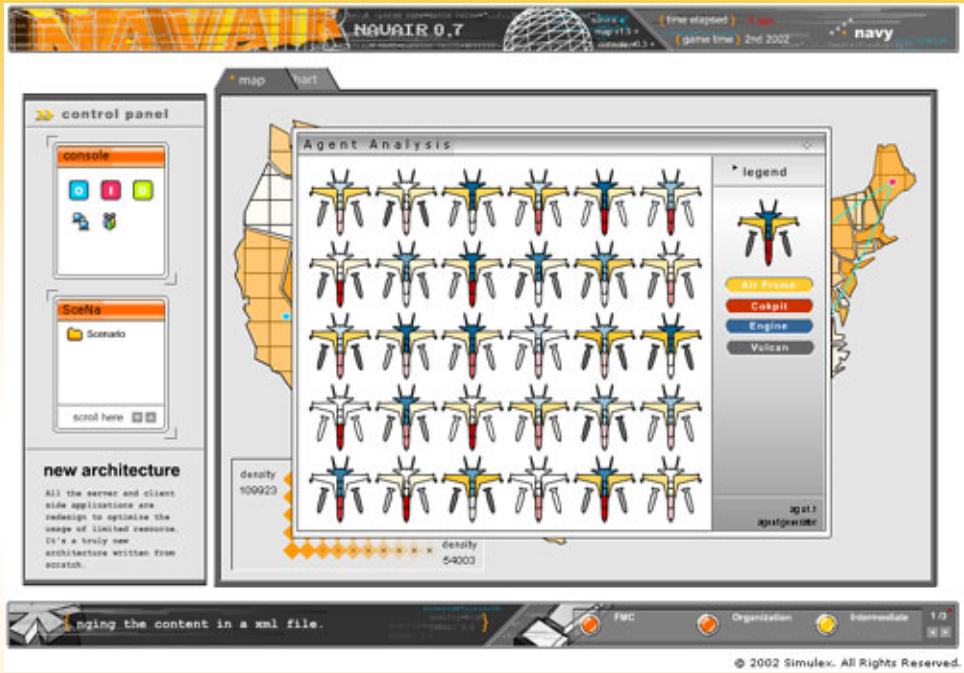
BP 2004 Lightweight Viz





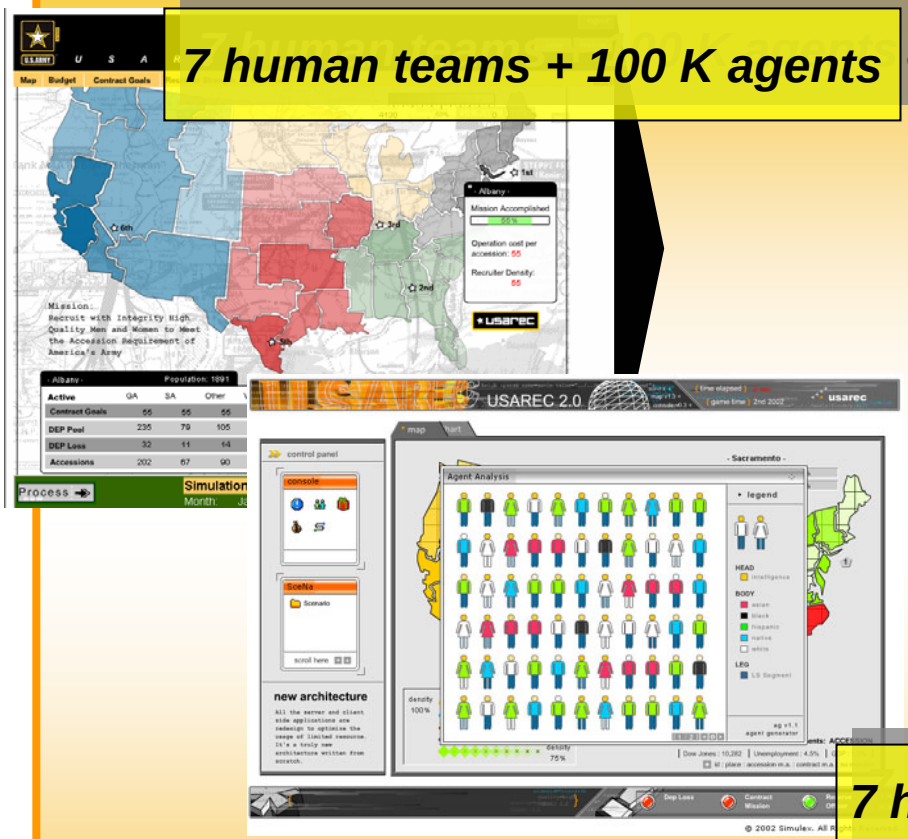
SEAS simulation of NAVAIR identified the appropriate business model to lower inventory cost while keeping the fleet readiness high for both peace time and combat scenarios

- Can NAVAIR anticipate supply bottleneck and interruptions
- How much risk is acceptable
- What business model will give best balance between cost and readiness
- What technology investments will enable long-term supply chain management



9 human teams + > 1000 agents + 3 different business models

SEAS simulation of USAREC identified some key findings for the Command leadership that helped them develop a more effective recruiting strategy

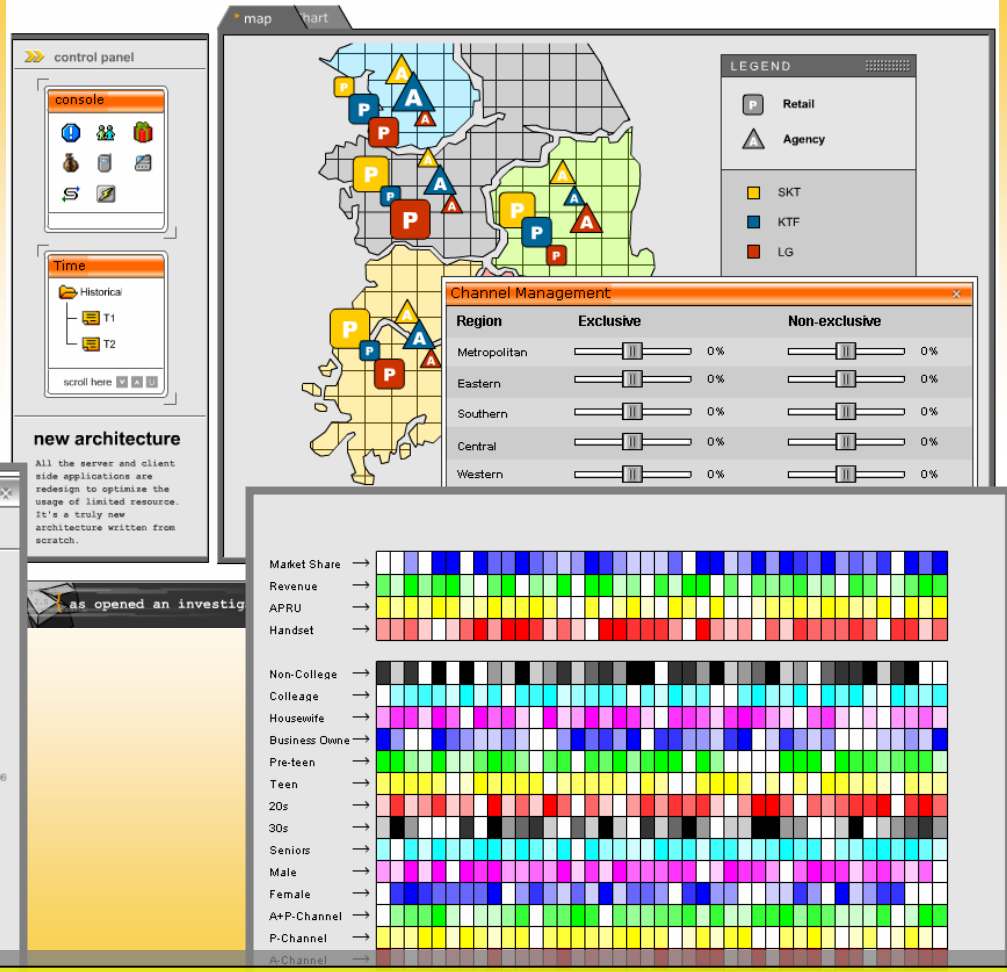


There were five key objective of the USAREC war game

- Improve decision-making throughout the USAREC chain
- Improve teamwork among all stakeholders
- Increase collaboration among all stakeholders
- Identify early warning signs of problem areas and develop counter strategies
- Assess, formulate, and test effective recruiting strategies

SEAS is helping a major Asian wireless service provider develop its 3G wireless communications strategy

- Multi-device with one UIM chip
- One number Roaming service between Service Provider
- Domestic roaming and international roaming
- Additional Services using memory in UIM chip (e.g. Address book, SMS mail box, Scheduler)



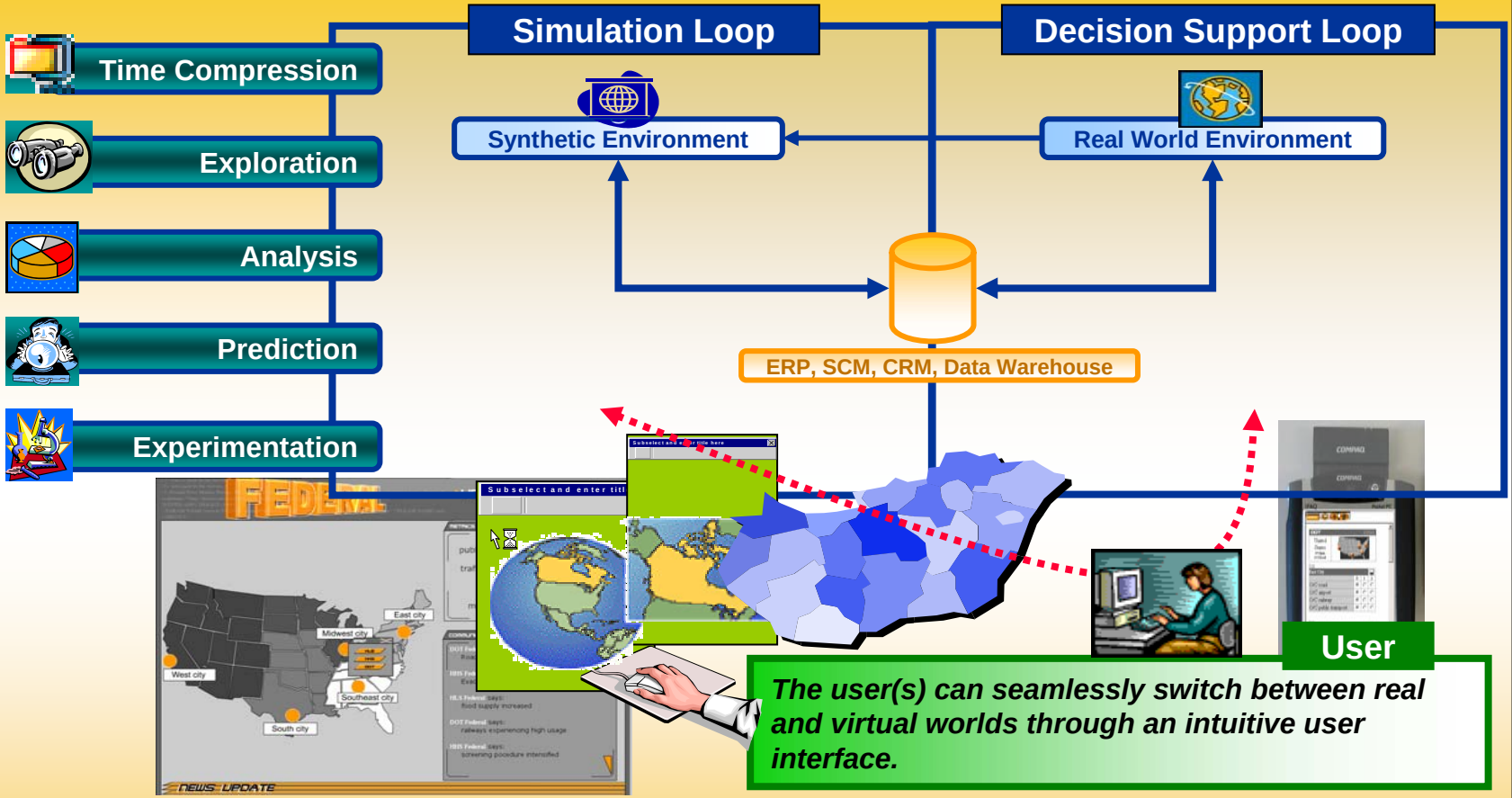
4 human teams + 300 artificial distributors, 3K retailers + 30K consumers

Purdue Model for Computational Homeland Security

Mission Statement

- To provide interaction workspace for different simulation tools
- To accommodate multi-paradigm simulations
- To enable distributed scalable simulations
- To build reliable simulation systems with unreliable components

Parallel Worlds for Continuous Experimentation

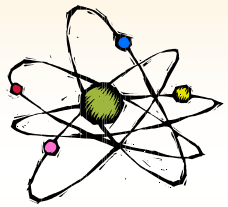


Experimentations in SEAS dramatically reduce the modeling / experiment design data gathering, analysis, implementation, evaluation cycle

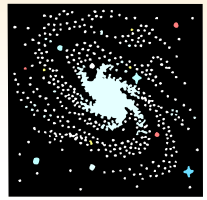
Computational Environments consist of ..

.. A world

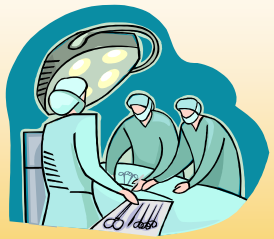
quantum



cosmic

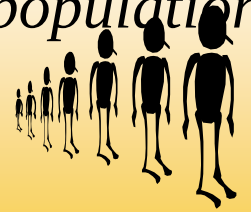


.. It contents



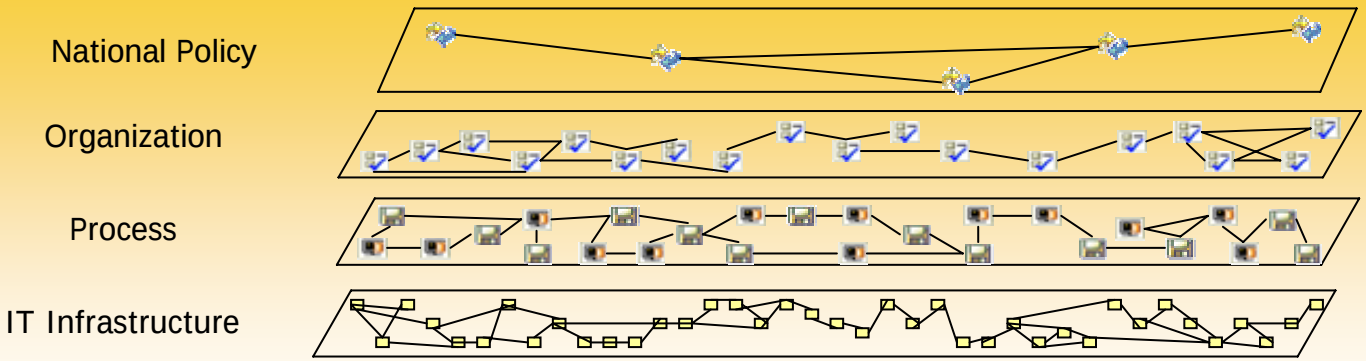
cell

population



Scalability and Multi Resolution

- Time

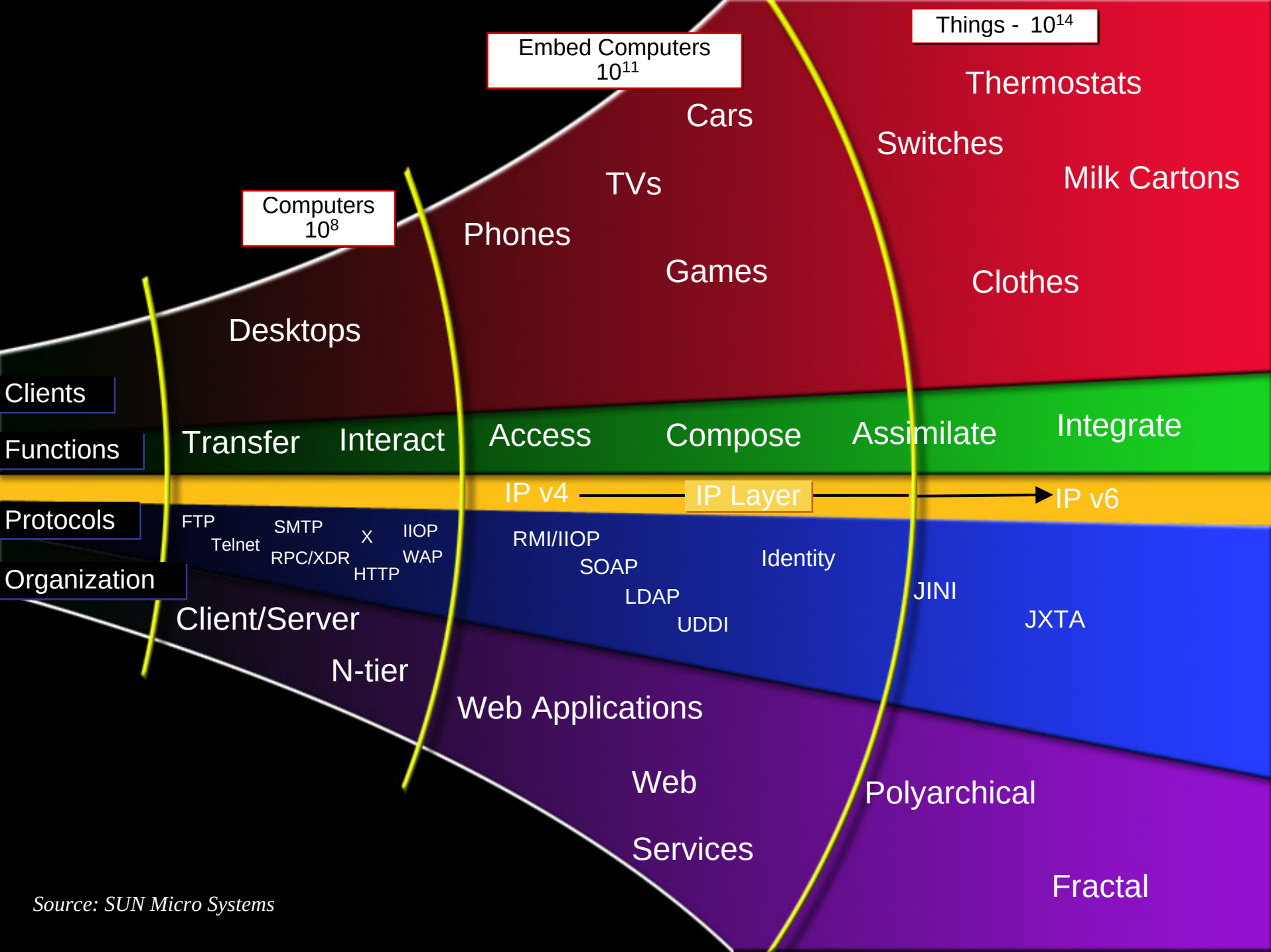


- Space/ expanse

---------- Bus ---------- ---------- ET

- Size

10^{-9} ---------- 10^{X}



Source: SUN Micro Systems

Obviously, there are challenges to it ..

- Common representation of knowledge from multiple disciplines
- Extremely large number of causal factors
- Difficult to perform multiple trials
- Human elements
- Repeatability and reproducibility
- Known and unknown inaccuracies of the model
- Multiple granularity in space and time
- Many other issues not listed here ..

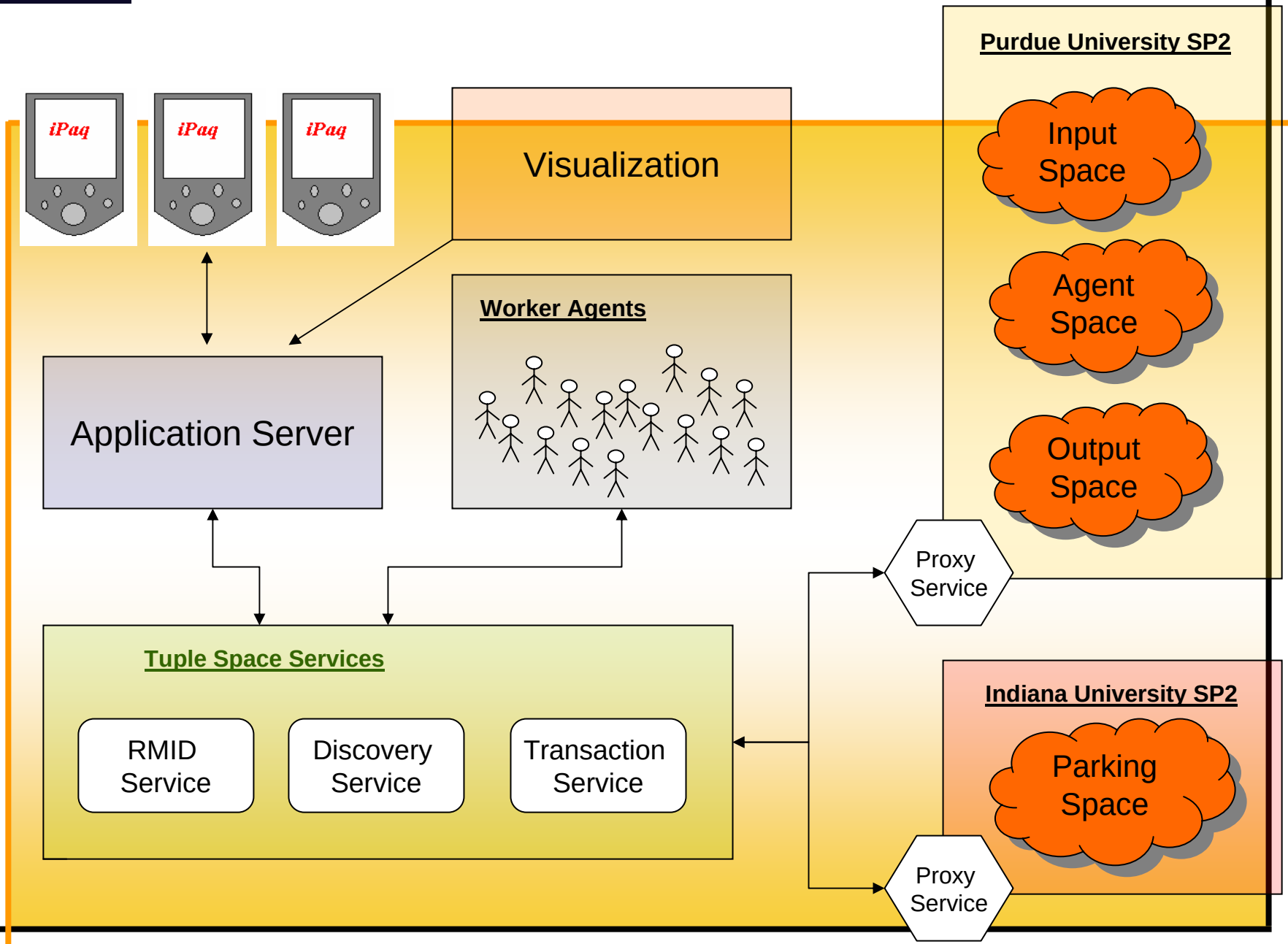
Concepts

- Shared reality space
  - Each simulation has its own reality
  - Subset of reality meant to be shared is published in the space
- “Agentification” of simulations
  - Simulations act like autonomous agents cooperating in a society
- Simulations do not communicate directly, but instead coordinate activities by exchanging reality through a space
  - Inspired by David Gelernter’s Linda Space
  - Shared, associative, transactionally secure

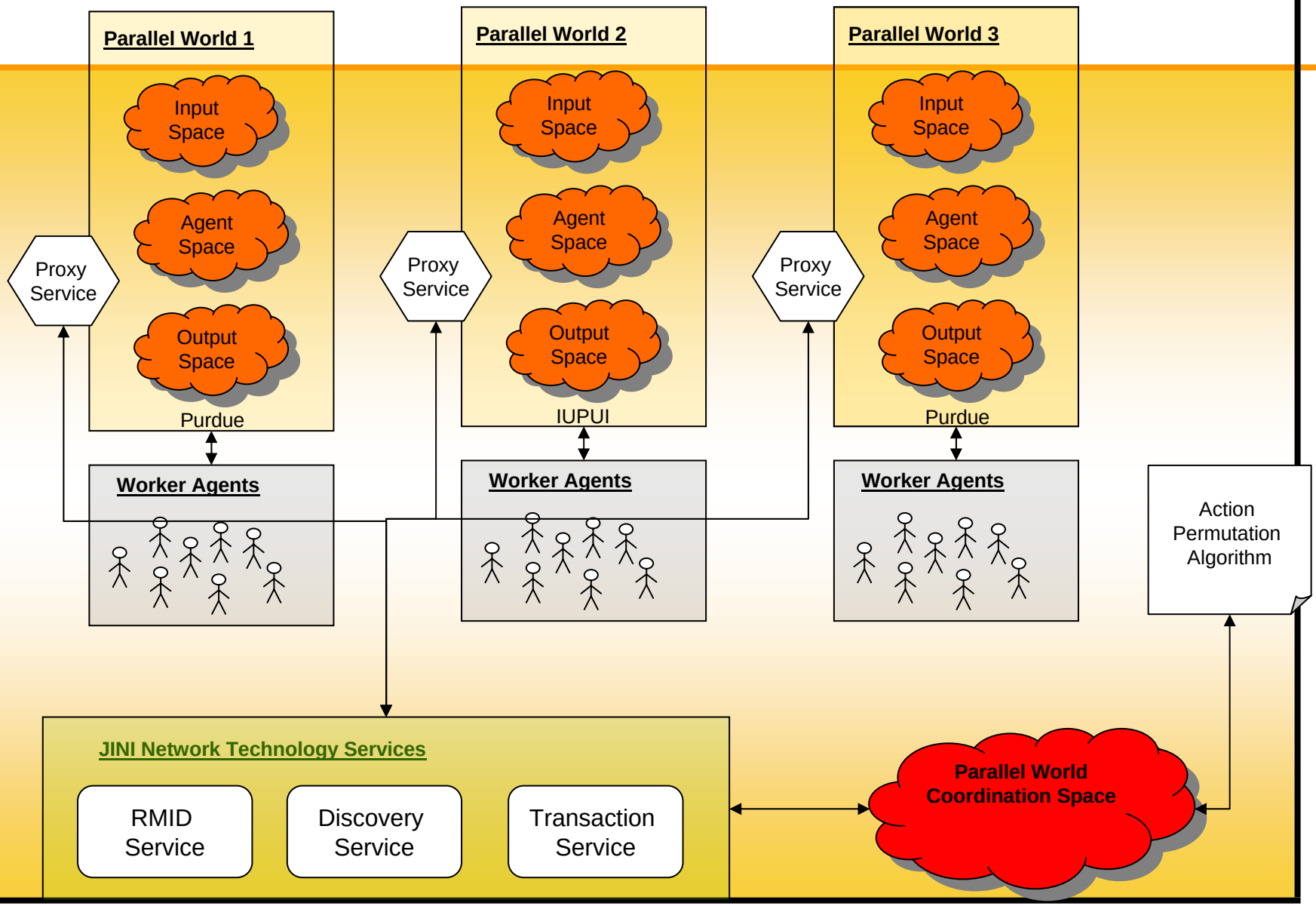
Benefits

- Capability to plug-and-play simulations seamlessly
  - Reduce complexity of introducing new simulations
  - Flexibility to adjust fidelity of simulations based on scenario
- Persistence of reality spaces allows failure recovery
  - Simulation can be recovered to its previous state based on the persisted reality
- Reality space as a basis for distributed simulation communication

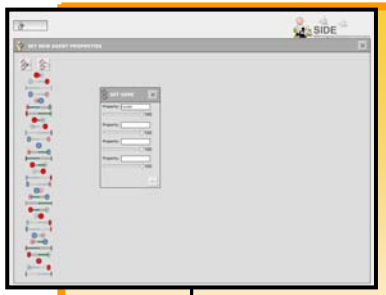
MR Technical Architecture



Scalable Parallel World Architecture



SEAS Modeling Concept of Operations



PLAN | Alert | Diagnose | Contact | Order | Replace | …

SIDE

JSIP

JIME

Workflow Model

Business Process Model

Organization Model

Infrastructure Model

Scenario Builder

Scenario 3

Scenario 2

Scenario 1

Organization

Op – SME - Tech

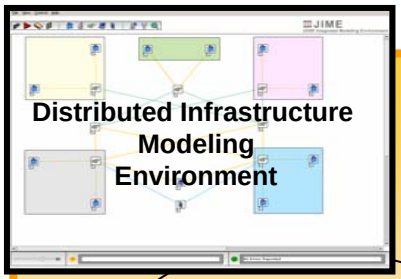
Business Process Model

Workflow Model

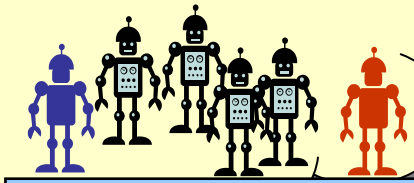
Infrastructure Layer

SEAS

Vision of Computational HS



Computational Experimentation and Analysis Environment (CEAE)



Behavior Modeling & Experimentation

CEAE Toolkit

Modeling Tools
- Economic Risk
- Infrastructure
- Human & Org. Modeling Tools
- Terror Cause & Effect Modeling

Visualization

Scenarios

Agent Population Tools

Behavior Extraction Engine

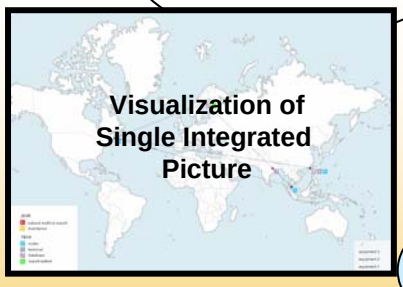
Data Acquisition & Fusion

Analysis Tools
- Design for Robustness
- Prevention & Early Warning
- Countermeasure
- Response & Recovery

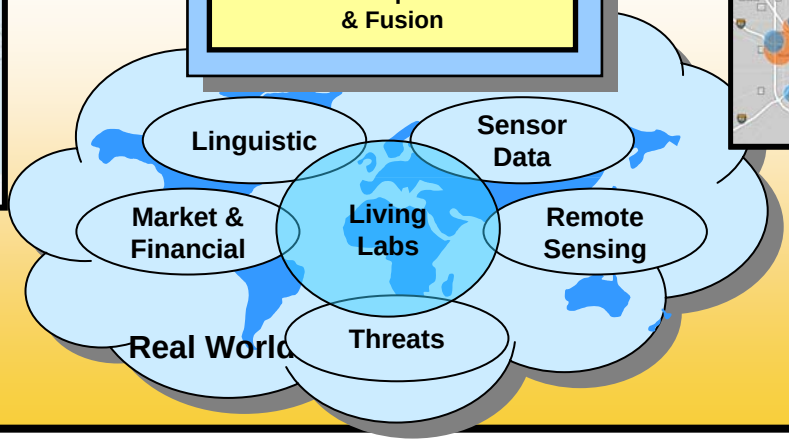
Contributors
- Universities
- National Labs
- Research Centers
- Think Tanks

Users
- Government Local, State, Federal
- Industry
- Universities
- Think Tanks

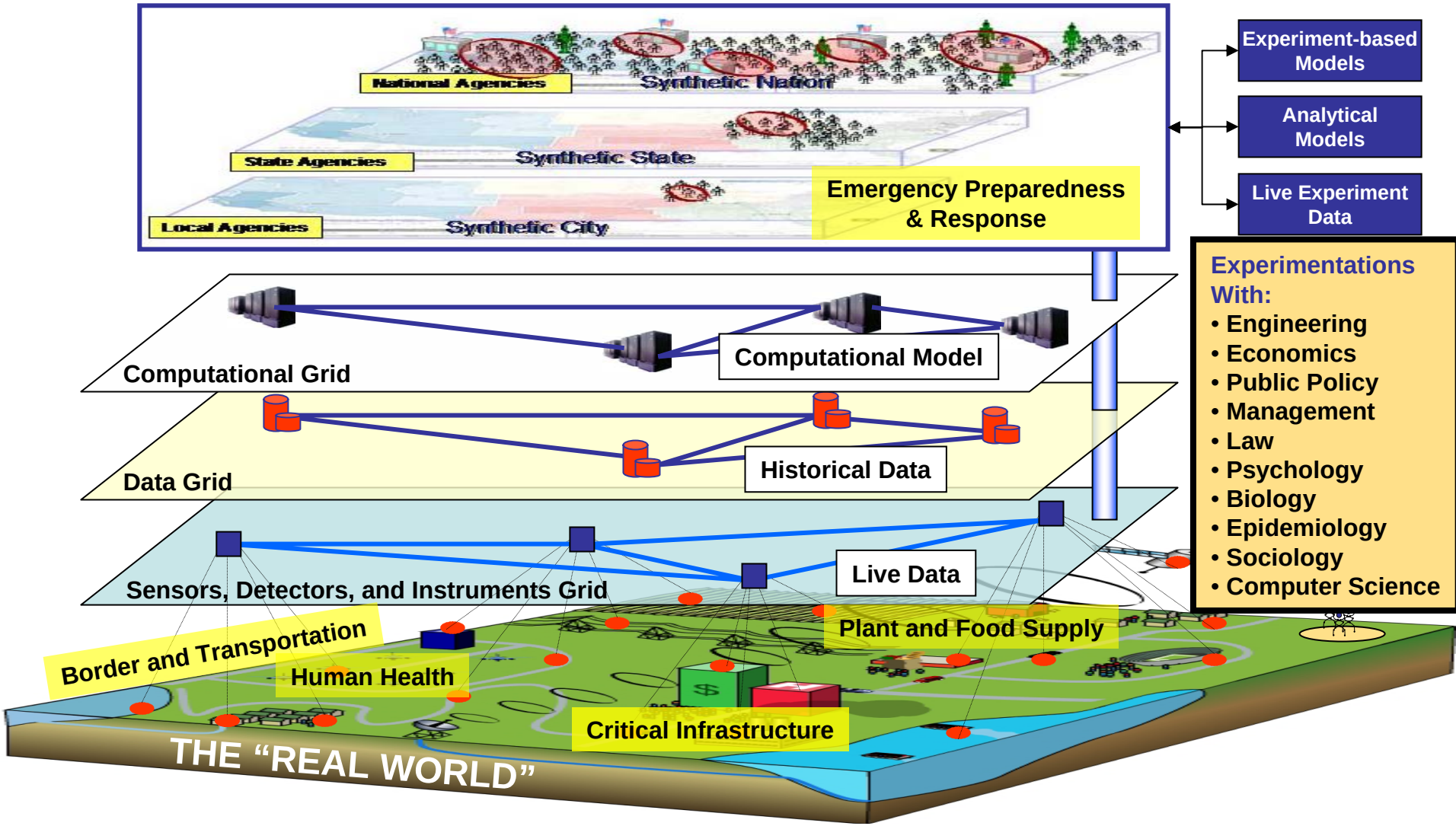
Engagement
Learning
Discovery



War gaming, Exercises & Experimentation



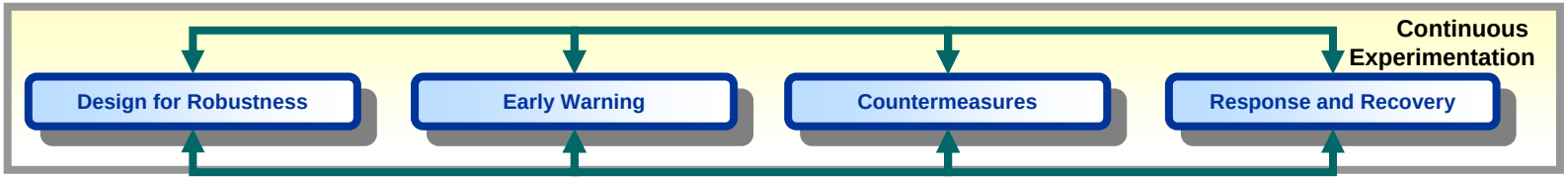
Building Computational HS



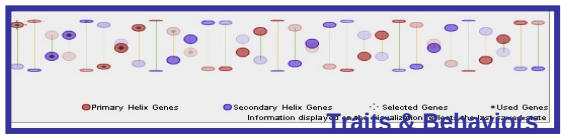
Modeling Framework & Tools

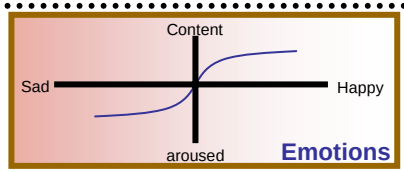
Web-based Collaborative Modeling Tools

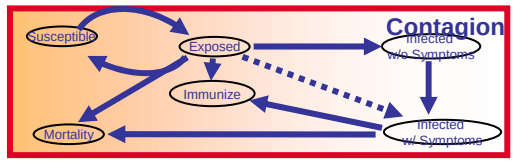
Gaming, Simulation, & Experimentation Framework



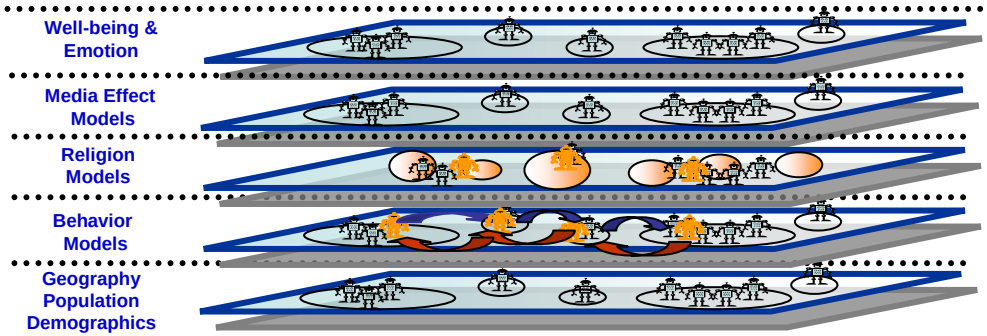
Agents' Traits, Emotions, & Contagion Models

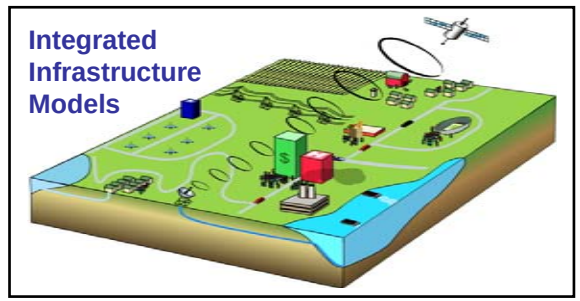




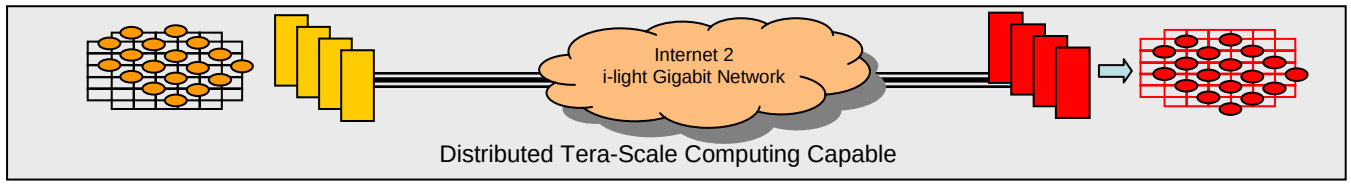


Population & Infrastructure Models

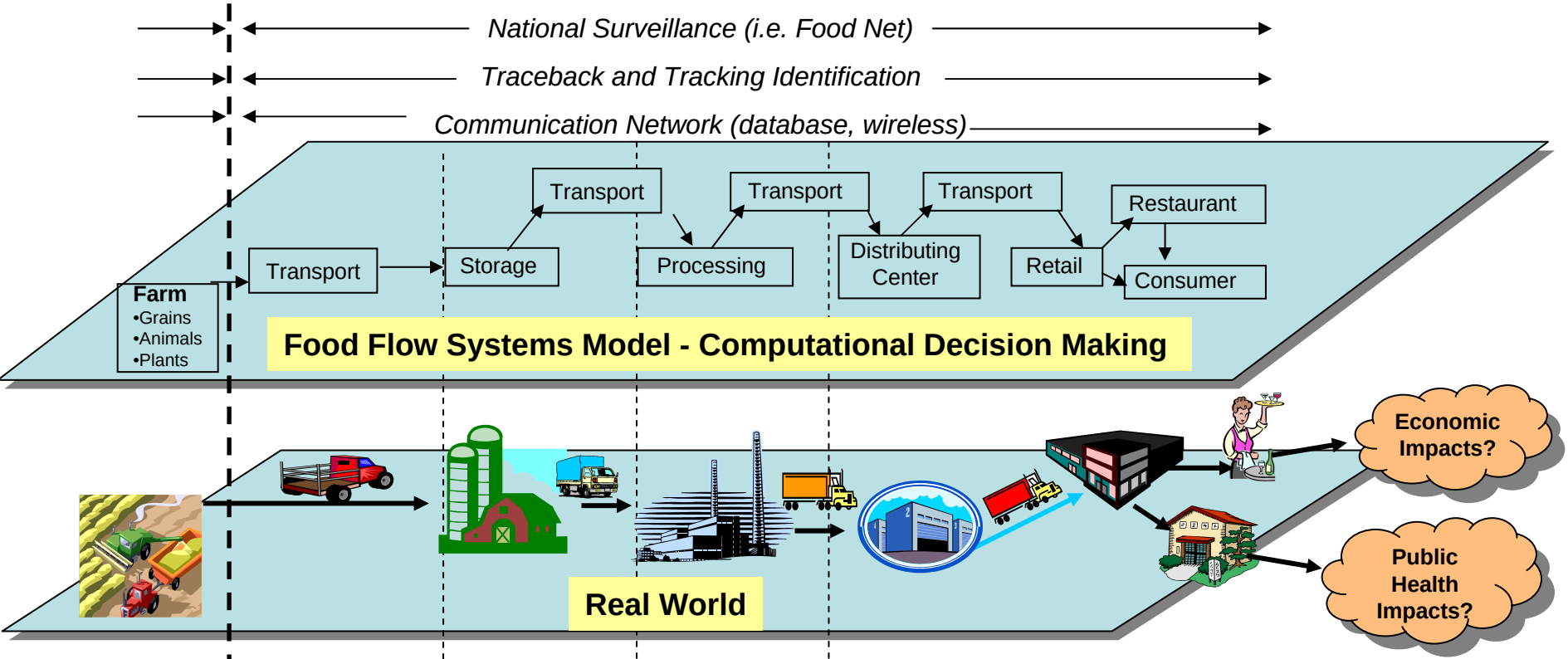




Computational Models -- Palm top to Teraflop



An Example



Source (Pre-harvest)	Transport (Post-harvest)	Storage	Processing	Retail & Consumption
Detection: ● ● ●	Detection:	Detection: ● ● ●	Detection: ● ● ●	Detection:
Response: ● ● ●	Response: ● ● ●	Response: ● ● ●	Response: ● ● ●	Response: ● ●
Recovery: ● ●	Recovery: ● ●	Recovery: ● ●	Recovery: ● ●	Recovery: ● ●
Prevention: ○ ○ ○	Prevention: ○ ○ ○	Prevention: ○ ○ ○	Prevention: ○ ○ ○	Prevention: ○ ○ ○

- ●: Biological Hazard
- ●: Chemical Hazard
- ●: Radiological Hazard

- ●: Mitigation
- ●: Investigation
- ●: Corrective action
- ●: Recall
- ●: Communication
- ●: Decontamination
- ○: Education
- ○: Risk Analysis
- ○: Good Business Practices

Predictive Modeling of Future Terrorism..

Weapons

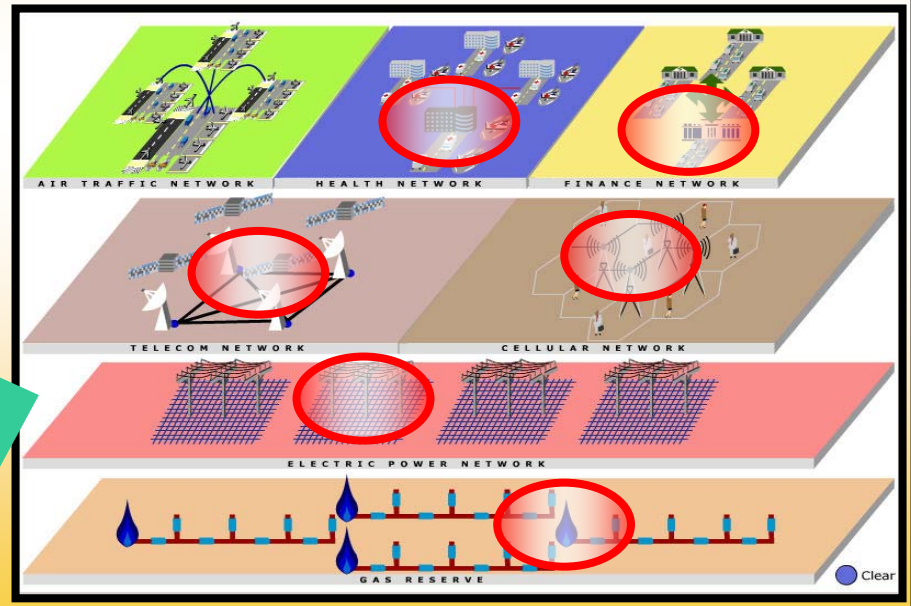
Small Arms
Improvised Explosive Device
Weapons of Mass Destruction (CBRNE)
Suicide Bombers
Computer viruses
Diplomatic, ideological, spiritual support
Commercially available equipment
Funding - Illegally generated & sponsored
Negotiations
Diplomatic Immunity
Sponsorship by Governments
Rogue Intelligence and Security Personnel

Terrorist Justification

Political Tyranny
Religious Oppression
Ethnic Oppression
Military Occupation
Guerilla Struggle
Religious Duty
Political Conviction
Social Conviction
Mystical Cult
Restoration of Political / Social System
Reactionary Terrorism

Attacks

Bombings
Genocide & Spontaneous Massacres
Forced suicide of victim
Depopulation or Ethnic Cleansing
Political Purges
Destruction or Damage of Structures and Resources
Hijacking, Kidnapping and Hostage Situations
Racketeering, Extortion, Drug Trafficking, etc…
Disruption of Communication Networks
Poisoning of Consumer Food Products
Threats & Hoaxes of Terrorist Actions

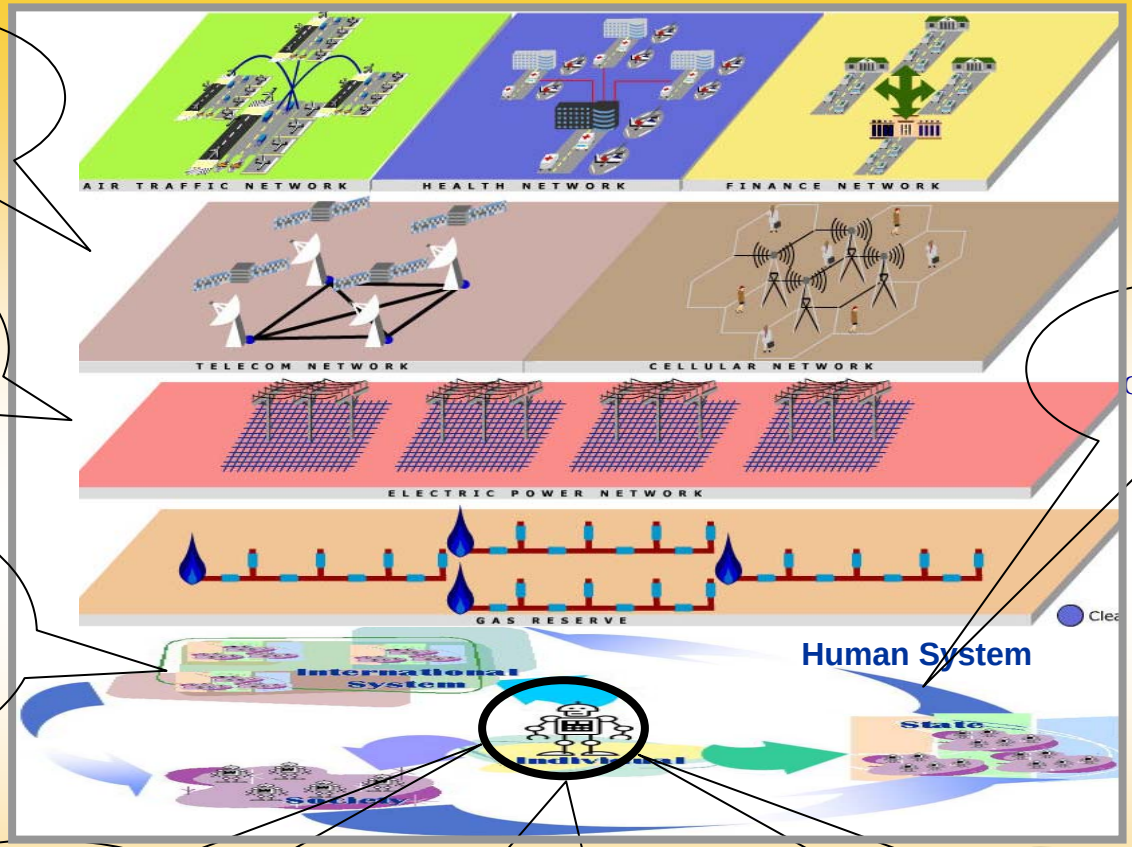


Modeling adversary's view point ..

Assessing physical and non-physical effects

Organizational Structure – Size, layers, tools, reach back, parallelism, timeliness

Fusion of all sources of Intelligence – Interagency, NGOs, Open Sources



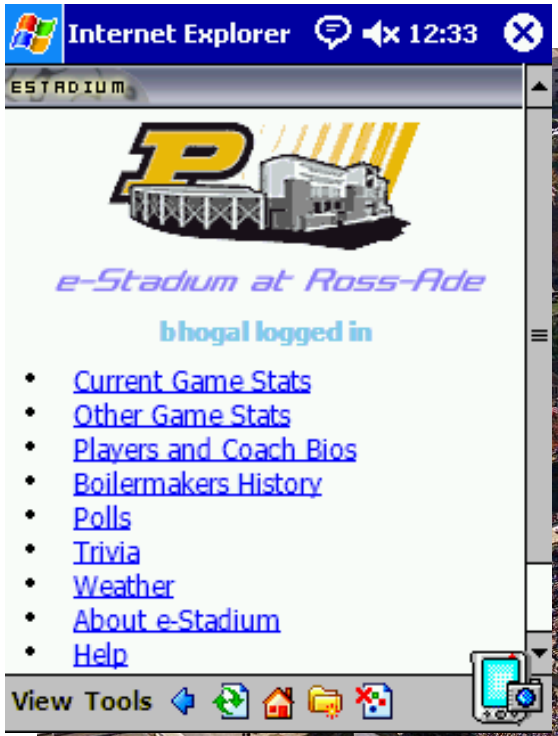
Impact of Globalization

Intelligence Collection Likes, dislikes, habits, strengths, weaknesses

Seeing thru' his eyes predicting reaction

Understanding behavioral influences

e-Stadium


Internet Explorer
12:33
ESTADIUM
e-Stadium at Ross-Ade
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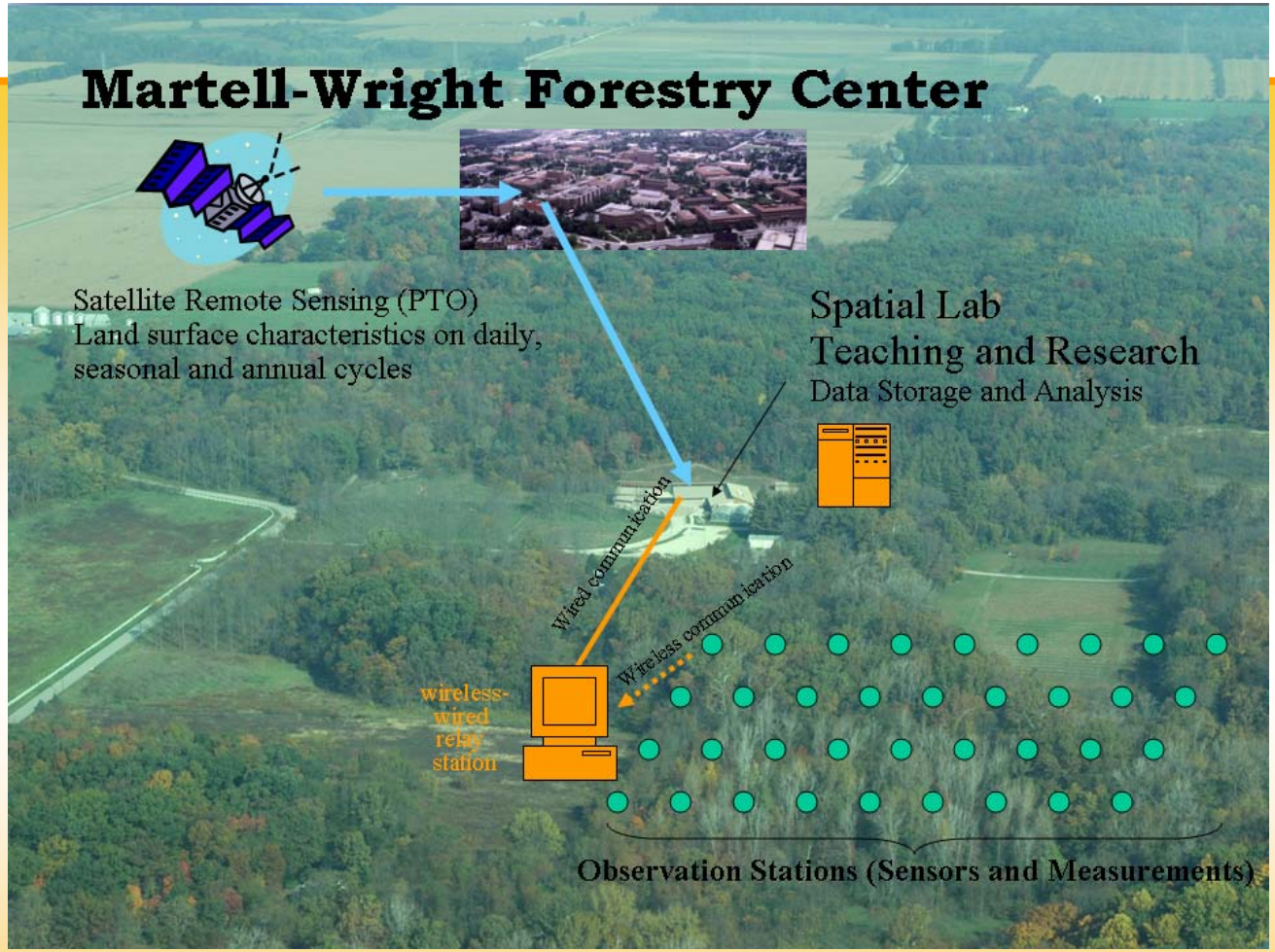
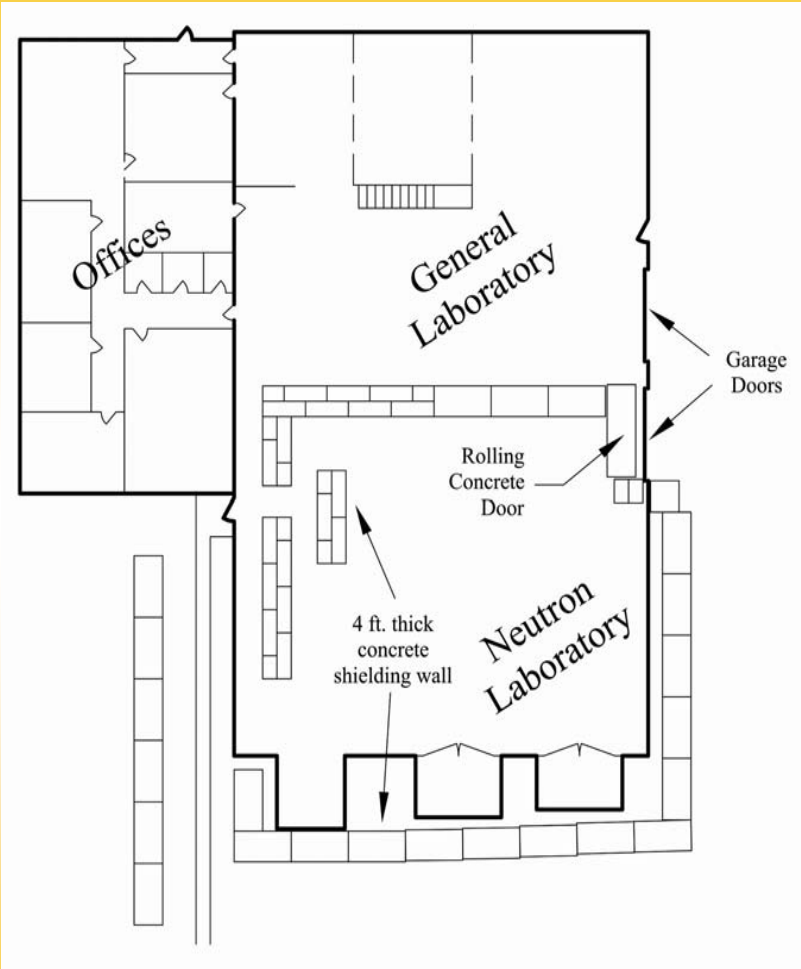
Current Game Stats
Other Game Stats
Players and Coach Bios
Boilermakers History
Polls
Trivia
Weather
About e-Stadium
Help
View Tools



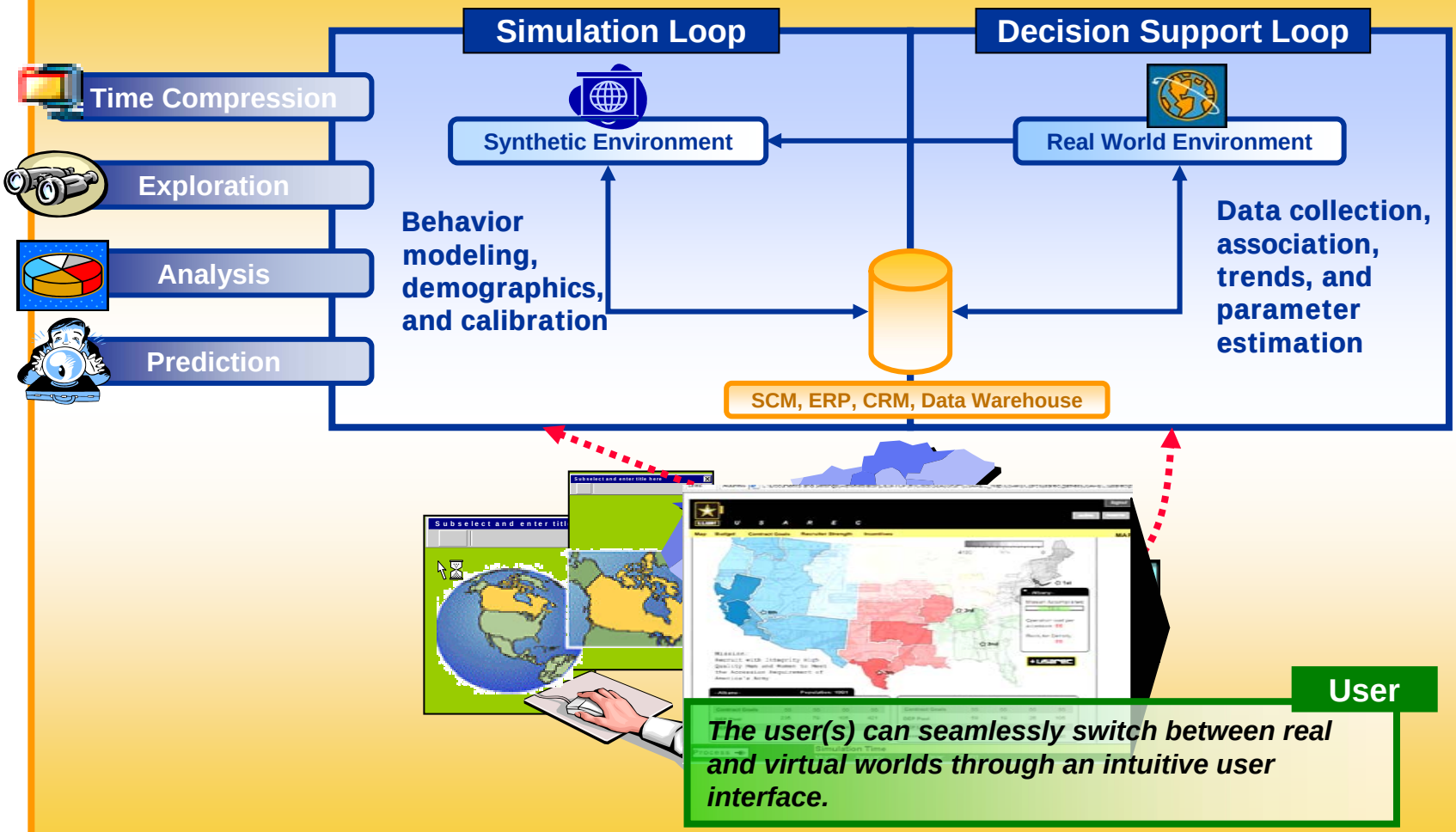
Project involves CWSA members from School of ECE, School of Mechanical Engineering, and School of Forestry

Neutron Lab



- 8000 sq. ft. total
- 1800 sq. ft. Office Space
- New Neutron Lab
- 4 feet thick concrete wall in main lab
- Class II Bio-lab
- Office Space
- 5 yr lease

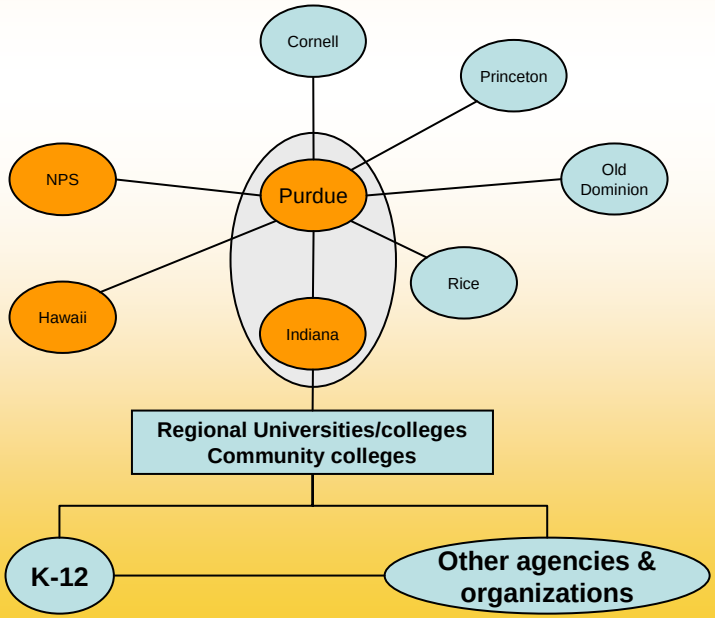
Computational Experimentation Environment



Curriculum Development

- Center for Forensic Science and Technology
  - Dave Tate

- Distributed Learning Model
  - Melissa Dark



Engagement

- Measured Response
  - 2003
- First Responders' workshop